USER MANUAL

- **-150V to +150V output**
- **DC to 5MHz @ -3dB large signal bandwidth**
- **2000V/µs slew rate typical**
- **±300mA Output current limit**
- **Stable with all capacitive loads, generates no overshoot**
- **Short-circuit protected output**
- **For MEMS devices, EO-modulators, PZT (piezo) positioning, beam steering, ultrasonics, …**

About this manual

This user manual is an integral part of the Falco Systems WMA-300 amplifier product. Please read it carefully and pay attention to the recommendations and the instructions for safe use.

General description

The Falco Systems WMA-300 is a high speed, high-voltage linear laboratory amplifier for demanding applications. Its wide bandwidth and large voltage range make it an excellent choice for use with MEMS devices, EO-modulators, PZT positioning systems, beam steering, ultrasonics, dielectric studies, and many others.
Through the extensive use of computer modelling and state-of-the-art design concepts, this amplifier can be used in many applications, including those where conventional amplifiers are difficult to apply. It is designed to be absolutely stable and free of spurious signals with any capacitive load.
The amplification is 50x (fixed). With a range of –150V to +150V, a large signal bandwidth of 5MHz @ -3dB and a typical slew rate of 2000V/µs, this amplifier will enable many measurements in different applications. Its frequency response is essentially flat up to 2MHz.

A fast current limit of ±300mA (typical) and a fast short-circuit protection make this amplifier suitable for both the normal daily laboratory use (and abuse), and automated measurement systems.

Safety

- This product is able to produce over 150V at more than 300mA at its output, which is a dangerously high level (risk of electric shock). Safety measures should be taken accordingly.
- Only use this appliance with a mains connection with protective earth
- The internal circuitry of the amplifier operates at high voltage. Only qualified personnel from Falco Systems should service this amplifier.
- When the amplifier is turned on or off, a short voltage spike may appear at the output which may damage circuitry already connected to it.
- Replace fuses with 250V 630mA 5x20mm slow blow rated fuses only.
- The Falco Systems WMA-300 is only suitable for indoor use in a class II environment (domestic, light industrial).
- This product should only be cleaned with a soft, slightly moist cloth. Unplug the WMA-300 from the mains power before cleaning.

Input protection

A high-speed amplifier like the WMA-300 can never be made fully insensitive to input overload conditions, as this would limit the performance of the amplifier to an unacceptably low level. However, compared to other circuits, the input is protected extremely well by a combination of a high-power 50Ω impedance and diode protection for extreme overload conditions. It can even withstand connecting the output to the input for some time, which may accidentally happen in a lab when cables are going everywhere.
For normal operation, input voltages should remain in the –3V to +3V range, resulting with an amplification of 50x in an output voltage swing of –150V to +150V. Above 3V (-3V), the input protection diodes will limit the voltage fed to the amplifier.
Above 30V (-30V) at the input, the amplifier may be permanently damaged if the current of the source is not limited. The output can be connected to the input because the current limit of the amplifier will cut back the voltage to a level that can be managed by the input.

Never apply more than +30V (-30V) to the amplifier input!

Output protection

The WMA-300 has been designed to be fully stable with all capacitive loads. It has been optimized for its step-response, but is also a very good linear and sine-wave amplifier.
Instability under capacitive loading conditions is a common problem of high-speed negative feedback amplifiers on the market, often resulting in unwanted overshoot voltages, and, in extreme cases, oscillations (check the respective manuals and datasheets for details). In the WMA-300, this problem has been solved by a clever dual feedback system. No significant overshoot occurs at any capacitive load.
Overloading or short-circuiting this amplifier will not break down the amplifier, due to the extremely fast current limiting circuit that has been employed.

Although the amplifier cannot be damaged by a short-circuit condition or capacitive loading, two situations should be avoided:

- *Connecting a charged capacitor*
- *Using high inductance values (coils)*

The load

The output impedance of the WMA-300 is 50Ω. The amplifier is generally used for high-impedance applications where the load is mainly capacitive. This is true for MEMS devices, EO-modulators and PZT's (piezo's) alike. It should be noted that a coaxial cable also presents a capacitive load of approximately 100pF/m. The cables that are connected may well limit the maximum usable current at high frequencies.

Matched loading with a 50Ω circuit is possible by connecting a 50Ω resistor in series with the output to ground, but is not usually recommended. The advantage is that excessively long cables will not distort the waveforms anymore. The disadvantage is a clearly reduced voltage range (300mA in 50Ω gives 15V instead of 150V).
With high-frequency measurements, cable length should be minimized or the cables themselves will cause overshoot and current limiting. Although the amplifier remains fully stable, more than 1.5 meter of output cable is not recommended for the WMA-300 for optimal results.
If output monitoring is required, it is recommended to connect a 10x oscilloscope probe to the output. A special BNC to probe tip connector is usually supplied with the probe (Fig. 1). However, the user can choose a different way of connecting the oscilloscope, as long as care is taken with the high output voltage. Pieces of non-coaxial cable in the connection can cause overshoot in the oscilloscope reading.

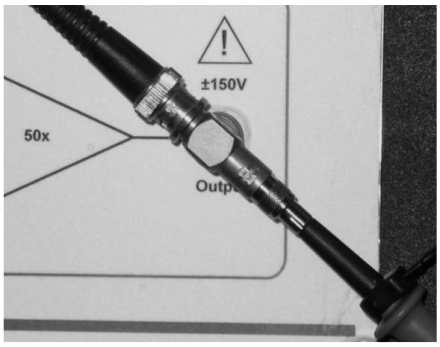


Figure 1. The 10x probe connected for monitoring the output signal

The amplifier should not be used for telecommunication as described in the R&TTE directive 95/5/EC. To prevent unwanted radio emission, the TDK ferrite ring which is supplied with the instrument should be mounted on the output cable close to the WMA-300 housing as indicated in Fig. 2, when square wave output signals above 100kHz and 50V are generated. In this case, the length of the output cable should be no more than 1.5 meter. The measurement is not influenced by this ring; it is only required to comply with European EMC legislation.

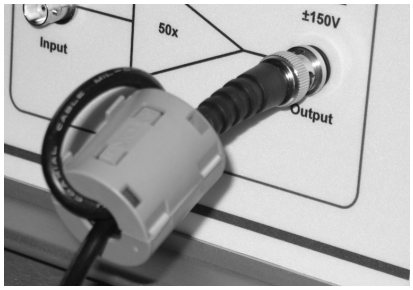


Figure 2. The ferrite ring (type TDK ZCAT3035-1330) should be placed on the output cable as indicated when a square wave of more than 100kHz and 50V is generated to prevent unwanted radio emission in the 30MHz region.

Amplifier characteristics

In the following pages, several amplifier characteristics are shown:

- Frequency response (Fig. 2, 3)
- Square wave response (Fig. 4, 5, 6)
- Slew rate (Fig. 7)
- Capacitive load dependency of square waveoutput (Fig. 8)
- Triangle and sine response (Fig. 9, 10)
- Noise and offset (Fig. 11)
- Input to output delay time (Fig. 12)

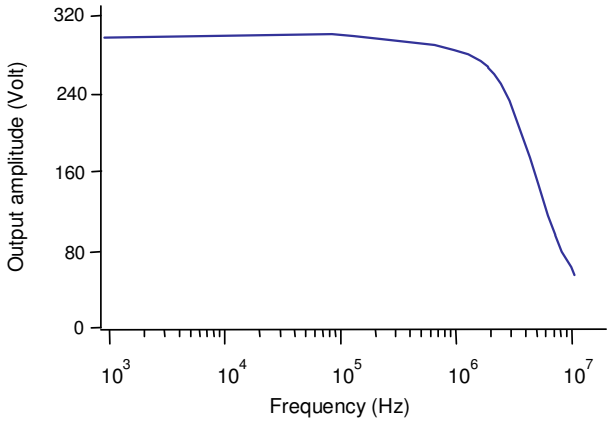


Figure 2. Frequency response at 300Vpp output voltage

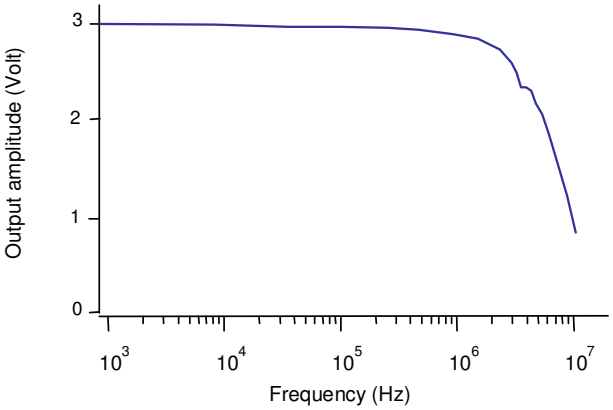


Figure 3. Frequency response at 3Vpp output voltage

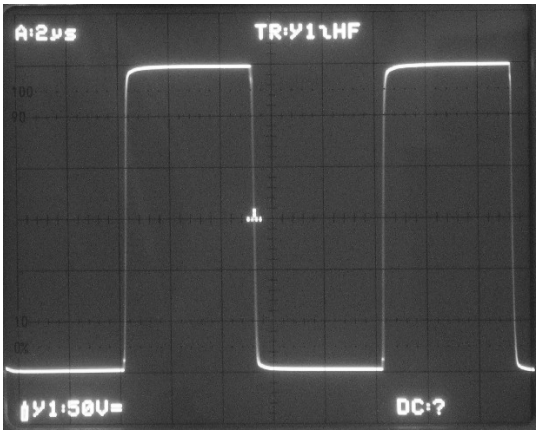


Figure 4. 300V_{pp} 100kHz square wave

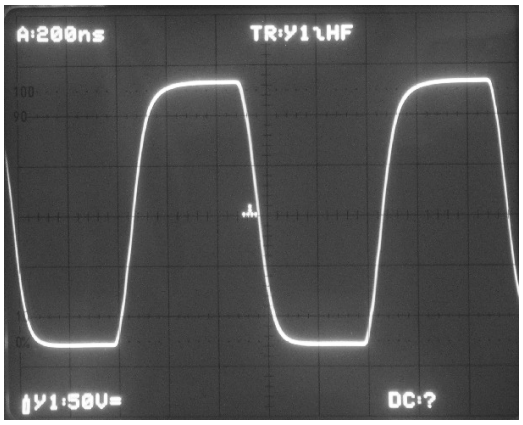


Figure 5. Full scale 1MHz square wave

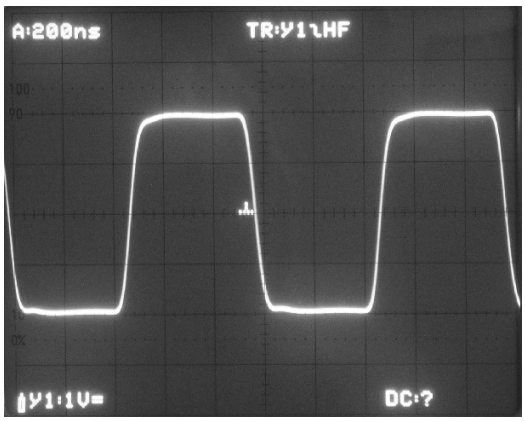
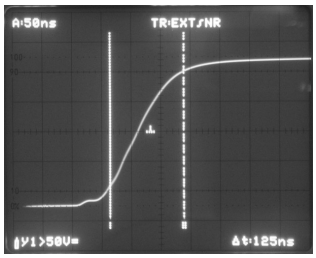
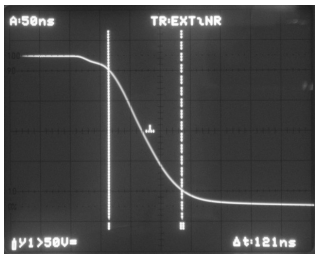


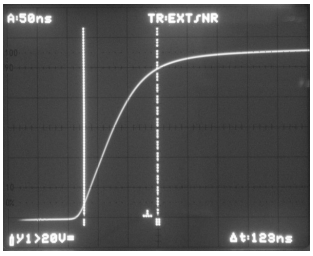
Figure 6. 4V_{pp} small signal 1MHz square wave



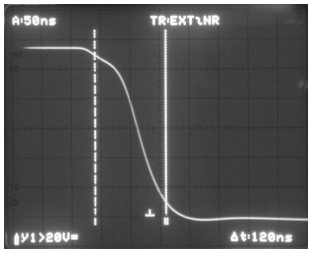
$300V_{pp}$ step up in 125ns



$300V_{pp}$ step down in 121ns

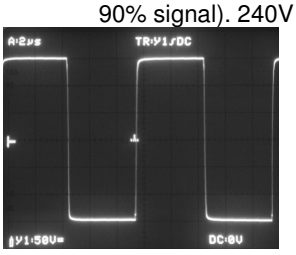


0V to 150V in 123ns

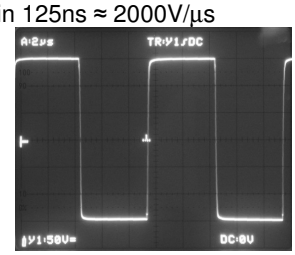


150V to 0V in 120ns

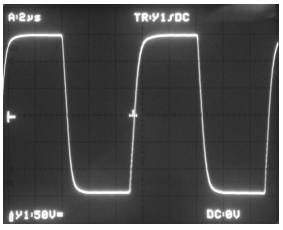
Figure 7. Slew rate (definition: step response from 10% to 90% signal). 240V in 125ns ≈ 2000V/µs



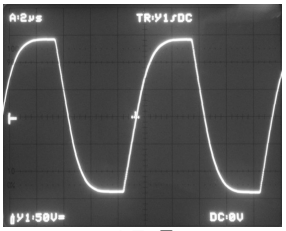
0pF



150pF



1.5nF



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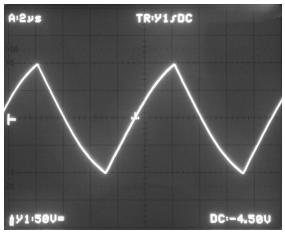

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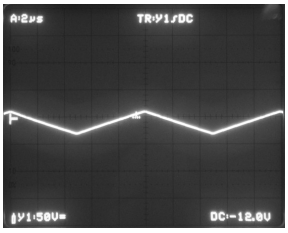

82nF

Figure 8. Full-power 100kHz square wave response with different capacitive loading conditions. The 300mA current limit limits the speed at which the capacitor can be charged.

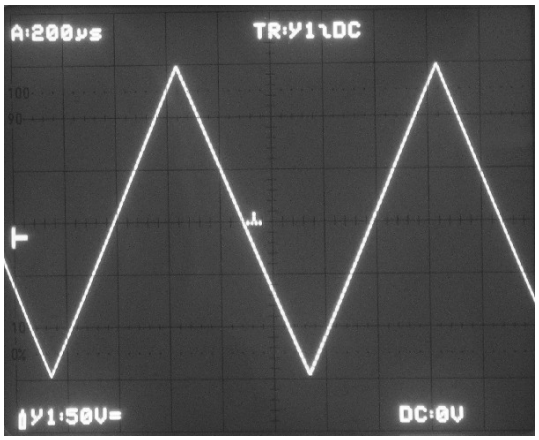

Figure 9. Triangle wave $300V_{pp}$ 1kHz

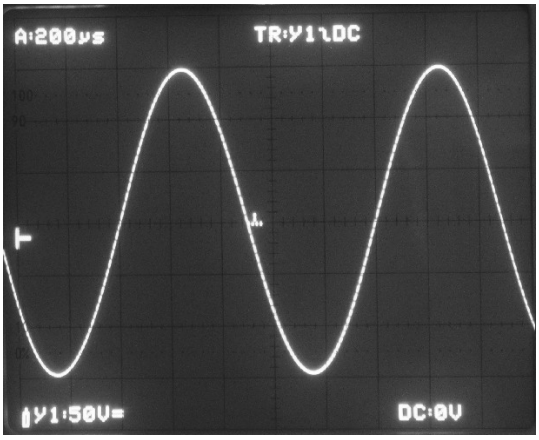

Figure 10. Sine wave $300V_{pp}$ 1kHz

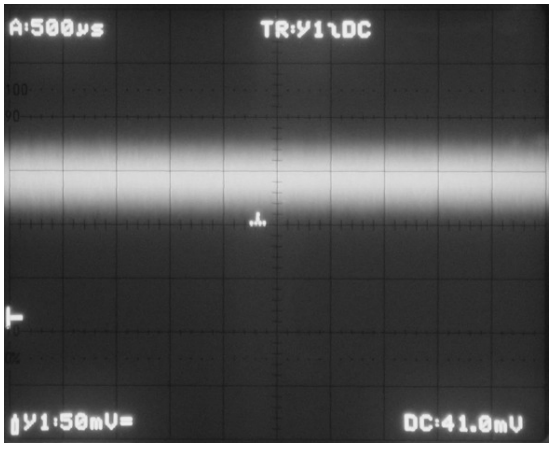

Figure 11. Noise (about $70mV_{pp}$ or, equivalently, 12mV rms) and typical offset. The offset may shift during high-power, high frequency operation due to temperature gradients between different parts of the circuit

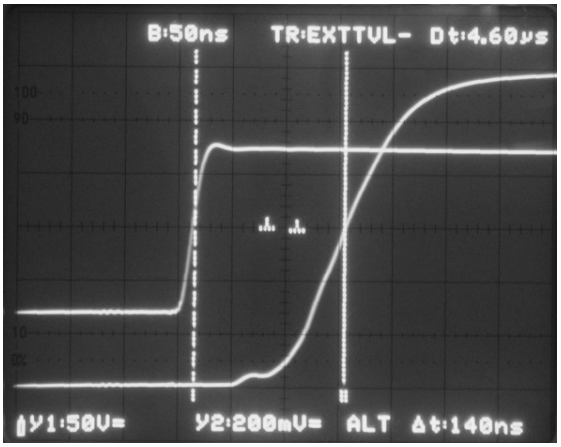

Figure 12. Input to output delay time = 140ns

Technical specifications

Amplification: 50x, fixed
Bandwidth: DC – 5MHz @ -3dB large signal bandwidth
Slew rate: 2000V/µs typical
Delay time: 140ns input to output
Output voltage: -150V to +150V
Current: 300mA typical with limiter
Noise and offset: 12mV rms noise over the full bandwidth typical, 100mV offset typical
Input impedance: 50Ω
Output impedance: 50Ω
Stability: stable with all capacitive and resistive loads, no overshoot > 5%
Power: 230V 50Hz AC, 120W
Mains fuse: 2x 0.63A 230V slow blow
Class 1 safety product: requires mains power supply connector with earth
Do not use non-sinusoidal mains power generators, indoor use only
Operating temperature: 15 – 30°C
Storage temperature: 0 – 60 °C
Relative humidity: 30 – 70% non-condensing
Dimensions: 280 x 280 x 160 mm
Weight: 6,8kg
Country of origin: The Netherlands

Specifications are subject to change

Warranty

Falco Systems products are guaranteed against malfunction due to defects in materials or workmanship for a period of 1 year from the date of shipment.

If such a malfunction occurs during this period, the product will be repaired or replaced (at our option) without charge. The product will be returned to the customer prepaid.
The warranty does not apply to:

- Exterior finish or appearance
- Malfunction resulting from use or operation of the product other than as specified in the user manual
- Malfunctioning due to misuse or abuse of the product
- Malfunctioning occurring any time after changes or repairs have been made to the product by anyone other than Falco Systems.

To obtain warranty service, the customer must inform Falco Systems first, and then send the product, prepaid, to Falco Systems together with a proof of purchase of the product in the form of a bill of sale or receipted invoice.
This warranty explicitly only covers the product itself. The repair or replacement including return to the customer are the only services provided to the customer in this respect. Falco Systems will not be liable for any consequential damages, including, without limitation, devices or equipment connected to the product, injury to persons or property or loss of use. See for more details the Falco Systems Standard Terms and Conditions of Sale.

User manual version

User manual version: 1.5
Date: February 21, 2012

Harmonized standards

This product complies with the following harmonized European standards:

Safety: EN61010-1
EMC: EN61326

CE

WEEE

Do not dispose of the WMA-300 as standard waste, but bring it to a WEEE electronic waste collection point.

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